EXAMPLES OF IMPLEMENTING MANURE PROCESSING TECHNOLOGIES AT THE FARM LEVEL IN THE BALTIC SEA REGION

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Manure from intensive livestock production in the Baltic Sea Region (BSR) is contributing to eutrophication of the Baltic Sea. Manure is used as a fertiliser resource for crop production, but there could be bottlenecks that prevent this fertiliser from being applied at the right time, at the right place (field) and at the right rate. Low concentrations of nutrients in manure make handling costly per kg nutrient (NPK) compared with mineral fertilisers and the costs of storing, transporting and spreading manure could easily exceed the economic value of the macronutrients in the manure. Soil could also become saturated with nutrients such as phosphorus, which would create a need to export manure off-farm. Common processing technologies for sewage sludge from wastewater treatment plants could potentially be used for manure, but farm conditions would most likely require modifications and adaptation when introducing new manure processing technology. The main objective of this study was to present case-study examples of manure processing technologies that have been implemented and used on livestock farms in the BSR. Farm conditions and the technologies were described and information such as capacity, motive for use and the economics of use were summarised for the different technologies. Technologies included in the study were nutrient concentration, slurry acidification, drum composting, mechanical separation and slurry cooling in manure channels. Specific examples of anaerobic digestion were not included. The technologies implemented were mainly for processing slurry and only one was for solid manure. The processing technologies presented had a capacity ranging from 1200 to 20 000 m^3 slurry per year. Motives for using manure processing technologies were many, including: decreasing the volume of liquid manure to handle, lowering the viscosity of liquid manure, reducing ammonia emissions and thereby complying with legislative requirements, improving air quality in livestock houses, recovering heat energy by cooling, and producing different qualities of fertilisers with higher nutrient concentrations for different applications. Other reasons were producing commercial soil and fertiliser products from manure (mainly solids but also liquids) and obtaining income from selling those products on market, and getting 201 tipping fees for organic products. In general, few farms in the BSR process manure and it was difficult to find example farms that implement processing technologies. Information on nutrient flows and balances was generally unavailable for the processing technologies under varying conditions. Such information is needed in order to analyse whether these manure processing technologies are actually reducing the environmental impact of livestock production. The technology for concentrating nutrients in manure is not yet commercially viable for farm use, while the other processing technologies are on the market, like mechanical separation and acidification. The estimated processing

costs were 1-7 EUR per m^3 slurry and year. The profitability of the investment depends very much on the income derived from selling fertiliser products, so an accurate and realistic farm-specific business plan for investment is strongly recommended, as external income could be the driver of good financial returns. It is also important to consider the whole handling chain, so that all components are resolved (e.g. how to spread new fertiliser products, plant availability, etc.) before investment.

Table 1. Manure processing technologies, farms, processing capacities, motives for investment and estimated costs on farms in the BSR (after Sindhöj & Rodhe, 2013). Costs include investment and operational costs. Annuity method is used to calculate investment costs based on 10 yrs depreciation and interest rate of 5%.

Processing technology	**Type of farm (country)**	**Processing capacity**	**Main motives for use by farmer**	**Costs, m^{-3} yr^{-1}**	**Incomes and savings not included**
Nutrient concentration technologies					
Split-Box, *prototype*	Dairy farm (SE)	Target capacity 15000 m^3 yr^{-1}	Reduce volume to store and spread	4.92	Less costs for storage, transport and spreading; possible fertiliser sale
Pellon, *prototype*	Pig farm (FI)	Target capacity 6000 m^3 yr^{-1}	Reduce volume to store and spread	3.81	
Reverse osmosis	Pig farm (NL), 1050 sows	10 000 m^3 yr^{-1}	Reduce volume, export solids and concentrate off-farm	6.49	Less costs for exporting manure, sold liquid fertiliser
Slurry acidification					
InFarm A/S	Pig farm (DK), produces 6500 finishers yr^{-1}	Max capacity NA, farm generates 3250 m^3 yr^{-1}	Ammonia abatement demanded by legalisations	6.68	Saved N; S fertilisation unnecessary
BioCover	Fictive pig farm (DK), 3800 places, typical for DK	Max capacity NA, farm generates 6000 m^3 yr^{-1}	Ammonia abatement demanded by legalisations	1.04	Saved N; S fertilisation unnecessary
Composting					
Drum composting	Beef cattle (SE), deep litter manure	Max capacity 18 500 m^3 yr^{-1}	Receives horse manure and vegetable waste, Produce commercial soil and fertiliser products	5.55	Income from tipping fees, sold commercial soil and fertiliser products
Drum composting	Pig farm (SE), 640 sows, 5500 places for finishers, plus beef cattle (150 nursing cows)	Max capacity 18 500 m^3 yr^{-1}	Pig slurry is separated to reduce slurry storage volume and solids composted, receives 13500 m^3 yr^{-1} solid horse manure, income from compost sold to a company that produce soil improvers.	3.96	Income from reduced volumes to store and spread and sold commercial soil and fertiliser products.
Mechanical separation					
Separation, screw press	Pig farm (FI), 600 sows, 2300 finishers yr^{-1}.	Max capacity 25 m^3 hr^{-1} pig slurry. Farm generates 1700 m^3 yr^{-1}.	Allocating of manure nutrients on farm, reduce odour, improved properties.	2.11	Saved logistic costs, better allocation of nutrients on farm.
Separation, centrifuge	Dairy farm with biogas (SE), 450 milking cows	Approx. 20 000 m^3 digestate yr^{-1}	Reduce volume of liquid digestate, lower P concentration in the liquid fraction.	1.62	Less costs for liquid manure handling (but costs for solids).
Mechanical separation					
Pellon	Pig farm (FI), 1000 fattening pig places	Max capacity NA, cools 1200 of 2000 m^3 yr^{-1}	Save energy, decrease emissions.	2.99	Saved N and energy

References

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